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AUTHOR	de Camilloni, Alicia W.; Fernandez, Marcela; Zadunaisky, Diana
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ABSTRACT

The University of Buenos Aires (UBA) is committed to a reform process which involves, among others, the curricular axis. The work described in this paper is part of the activities specially concerned with the studies of engineering. Seventy-five professionals were invited to discuss new possible patterns for the perspective of the professional fields of engineering, suitable to redesign the structures and contents of the engineering university programs. To accomplish this goal, the Secretary of Academic Affairs of the UBA organized a series of meetings based on the construction of future scenarios, not only the possible ones but also, the desired ones. The recommendations that derived from this work are a very important contribution to the curriculum reform in engineering, as they are the result of a variety of professional experiences and points of view on the present and future needs of the work market for engineers. This paper summarizes the main ideas that were discussed. It is remarkable that in spite of the very heterogeneous characteristics of the participants, many coincidences were found. This material can be taken as a real basis for curricular reform in engineering university studies. (Author)

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Reform Process In The University Of Buenos Aires: Perspective Of The Professional Fields Of Engineering

Alicia W. de Camilloni, Marcela Fernández, Diana Zadunaisky
(with the collaboration of Julia Demaziz, M. Anita Fernández and Verónica Nespereira)
Secretary of Academic Affairs. University of Buenos Aires.
Ciudad de Buenos Aires, Argentina 1053

Abstract *- The University of Buenos Aires is committed to a Reform Process which involves, among others, the curricular axis. The work we describe in this paper is part of the activities specially concerned, in this case, with the studies of Engineering.*

Seventy five professionals were invited to discuss new possible patterns for the perspective of the professional fields of engineering, suitable to redesign the structures and contents of the Engineering university programs. To accomplish this goal, the Secretary of Academic Affairs of the UBA organized a series of meetings, based on the construction of future scenarios, not only the possible ones but also, and better, the desired ones.

The recommendations that derived from this work are a very important contribution to the curriculum reform in Engineering, as they are the result of a variety of professional experiences and points of view on the present and future needs of the work market for engineers.

This paper summarizes the main ideas that were discussed. It is remarkable that, in spite of the very heterogeneous characteristics of the participants, many coincidences were found and this material can be taken as a real basis for curricular reform in Engineering university studies.

Introduction

The University of Buenos Aires is committed to a Reform Process which involves, among others, the curricular axis. The work we describe in this paper is part of the activities specially concerned, in this case, with the studies of Engineering.

Seventy five professionals were invited to discuss new possible patterns for the perspective of the professional fields of engineering, suitable to redesign the structures and contents of the Engineering university programs. To accomplish this goal, the Secretary of Academic Affairs of the UBA organized a series of meetings, based on the construction of future scenarios, not only the possible ones but also, and better, the desired ones.

The main issues that were debated were: two cycle studies structure, and the corresponding contents; articulation between undergraduate and postgraduate studies; degrees; present and future profile of the engineer; industries and business needs; orientations of undergraduate studies.

This paper summarizes the main ideas that were discussed and the recommendations that derived from this work, which are a very important contribution to the curriculum reform in Engineering, as they are the result of a variety of professional experiences and points of view on the present and future needs of- the work market for engineers.

Problem Formulation

Previous discussions in the University of Buenos Aires led to a description of the transformations that took place recently in the scientific and technological fields, in the production of goods and services and in the work field as well. The present context of uncertainty was also included, as an additional difficulty to make predictions concerning the future. As long as the University is an anticipation project of scientific and professional education and of production of knowledge and services, this framework leads to rethinking, restructuring and redesigning the education programs offered, with the double aim of satisfying the needs and interests of the individual persons and of the society.

The curricular reform, particularly in the Engineering field, is requested to anticipate, understand and cope with the new scientific, technological and work scenarios.

Several dimensions of the reform were established: dividing the curriculum in cycles, shortening the length of the studies, defining the structure of degrees, merging practical and theoretical studies.

This work was conducted in order to discuss some of these issues from the point of view of the Engineering professional fields.

Approach And Methodology

In order to face the challenge of Engineering education, there is a need for thorough discussions. From many different sectors in society we must learn the demands, opinions and suggestions on this issue, so important to provide the engineers that can be able to meet the challenges of the 21st century. Obviously, not only engineers or Engineering university professors are to

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be listened to. A wide range of professionals from different areas, scientists, technologists, manufacturers, managers should be given the opportunity to collaborate actively and systematically in these discussions.

Following this approach, we developed a methodology that tends to the alliance between university on one hand and industry, technology-based business, consumers' demands and other Engineering-related sectors on the other hand.

The methodology was based on the organization of successive meetings, inviting outstanding people related to different sectors of society to debate specific issues of Engineering education.

Three meetings were held, in which the participants received several questions on specific subjects, they discussed them in small groups and they drew conclusions that were later communicated to the rest of the participants, giving way to an extended debate. Some of the participants were invited to two meetings, to make a link between the discussions that took place in the different occasions. About 25 people were gathered in each meeting, and they worked in groups of 5.

The composition of the groups was heterogeneous and representative of different activities involving Engineering and related subjects: professionals working at leading industries in technological and managing positions (in our country and abroad), professionals working at engineering related companies, university professors, researchers, business men, experts, members of professional associations, students. They were involved with the different branches of Engineering (Constructions, Mechanical, Electrical, Electronic, Chemical, Industrial, Systems) and with related areas such as: Basic Sciences, Pharmacy, Biochemistry, Economics, Architecture, Agriculture.

The fact that many of the participants from industry and business did not have a present university involvement allowed a way to external contributions to the University.

To define and elaborate the questions posed to the participants, we had the collaboration of experts specialized in the field of labor studies.

The conclusions of each meeting were later written and distributed to the participants. They were also given to people invited to the following meetings, so as to obtain a cascade process.

A second stage of this work is being conducted presently. It consists in asking for opinions on the conclusions of the three meetings to a large number of people with the same heterogeneous Engineering-related profile that the participants had. The addressees receive a summary of the conclusions together with a form with precise and open questions to be answered. These answers, as far as we received them by now, support the previous conclusions and also bring new suggestions or open new questions to discuss.

When this stage is completed, we will be able to guarantee the validity of the developed methodology, and use it successfully for the discussion of curriculum in a variety of knowledge areas.

Results And Conclusions

In general terms, all the groups agreed to recommend:

- Structuring the programs in two cycles.
- Shortening the length of the studies to 5 years programs.
- Providing previous orientation and leveling to 1st year students.
- Giving a more general engineer education, with late specialization related to the business world's needs.
- Strengthening the integration among different Faculties of the University.
- Emphasizing basic sciences and "basic engineering science" contents as well.
- Offering a great number of postgraduate courses to provide specialization and recyclation, with a suitable articulation with the undergraduate courses.
- Increasing the number of full-time teachers.
- Designing a scholarship policy to allow students to increase their dedication to studying activities.
- Giving an academic non professional 1st Cycle certificate.
- Including student placement, professional practice and/or graduation thesis in the undergraduate curriculum.
- Developing the present interdisciplinary contacts with Architecture, Economics, Law and Basic Sciences.
- Creating new degrees, with an important interdisciplinary content.
- Discussing and defining the branches, orientations and specializations of Engineering studies.
- Educating engineers for a rapidly changing professional world, linking study with reality.

A great number of partially agreed contributions were also made. We have selected three main subjects for which we summarize the principal ideas that were proposed.

Features Of The 1st Cycle : The Education In Basic Sciences

One of the points with which most of the participants agreed was the 2-cycle structure of the programs, being the 1st cycle mostly dedicated to the education in basic sciences and technologies, and the second one giving an amount of specialization.

General features

The participants described the context of strong and rapid changes in the technologic realm and in the production systems, and the perspective of a future with unforeseen changes.

Obviously, these changes should be correlated to changes in the methodologies and contents taught

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at the university in order to prepare the young professional to face this variable context.

What are needed is mainly professionals with a well developed capacity of adaptation.

Strengthening the basic education was proposed as a way to accomplish this goal, involving the core knowledge that is the base to all technologies and techniques, and that doesn't change much.

Teaching a solid core of basic knowledge helps students to "learn how to learn" which is the skill needed to be able to recycle and adapt themselves to new situations, to rotate through different positions, to learn new technologic developments, to work in different industrial environments, to face different employment needs, to cope with changes in orientation or specialization. The basic education would be a reassurement in view of the great difficulty to foresee the socio-economic environment evolution.

Contents of the 1st cycle : the basic sciences and technologies

A statement was made that basic education should provide the tools to understand nature and the relationships within society.

The contents proposed were: basic sciences (mathematics, physics, chemistry), languages (mainly English), basic PC operation, general culture subjects (ethics, logic, philosophy, ecology, cognitive psychology) and working skills (leadership, interpersonal relationships, team work, problem solving).

Some suggested including economics, financing and managing skills too, but a discussion was held about which was the best moment to introduce these themes: early o later in the program.

Environmental subjects were also mentioned as related to every discipline taught.

The participants pointed out that, even if the 1st cycle has to deal with the basic sciences, these have to be taught closely linked to their application in technology.

Some professors mentioned that some specific engineering themes should also be taught in the 1st cycle to prevent students from discouraging and quitting the program.

An idea was set forth, about the "basic sciences of Engineering", namely micro and macro economics, industrial organization, logistics, etc.

The 1st cycle was proposed to last 2 years. It was suggested that it could be common to different orientation studies in Engineering. Some even mentioned the possibility of taking modules in different Faculties, as long as the contents are equivalent.

An academic certificate could be awarded on completing the 1st cycle. This certificate would not allow to perform any kind of professional work, but it could give a recognition to teach at the high school level.

It was finally stated that the education in basic sciences should continue in the 2nd cycle, together with specialization subjects.

Features Of The 2nd Cycle: The Orientations

General features

The 2nd cycle must be articulated with the 1st cycle and the postgraduate studies.

An overall agreement was not achieved concerning the amount of specialization that the 2nd cycle should provide to the undergraduate student, ranging from a general engineering study plan with low specialization (studying only the main branches of Engineering) to several particular study plans with different orientations and an appreciable specialization.

Orientations and degrees

The idea of considering a degree without much orientation was supported by the statement that it is unlikely that the engineer will always work in the same area or subject. It was also said that "general" engineers could be better prepared to face changes in technology, management and work styles.

Considering orientations, a proposal was made to group them in just two principal areas: materials (including Civil, Mechanical, Industrial, Chemical Engineering) and electrons (including Electronic, Electrical, Communications, Computers Engineering).

Many of the participants proposed to choose about four main branches, from which several other minor orientations could be derived. They described a modular pattern of study plan, involving a number of optional modules related to the special orientations. Different ways of choosing these main branches were shown, but all the sets included Civil and Electronic Engineering. Then the sets were completed with Electromechanical, Industrial and/or Systems Engineering. Also mentioned was Chemical Engineering.

From a general point of view, many of the participants pointed out that the University must not be just linked to the present economic and industrial characteristics, but should consider the creation of programs for possible future needs. Within this scope, the following possible orientations were suggested:

- Digital Technology
- Voice and Data Communications
- Environmental Engineering
- Natural Resources Engineering
- Industrial Measurement and Statistics
- Organization Engineering
- Manufacturing Engineering
- Aeronautical Engineering
- Production Management
- Building Services Engineering

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Some multidisciplinary programs were also proposed:

- Food Engineering
- Bioengineering
- Materials Engineering
- Animal Production Engineering

Following a different approach, a way of organizing the contents of the programs of Engineering was proposed, regardless of the orientation, in four areas: Mechanics, Materials, Design and Management.

Relationship with industry and society

An overall agreement was reached to include industrial placement, professional work, and/or undergraduate thesis work as a part of the undergraduate study plans. The three options allow relating academic studies to practical situations; while the first provides industrial training, the second focuses in problem solving and the third opens the way to research activities.

Graduates' Profile: Prospectives

Thorough discussions took place on the subject of the profile of the Engineering graduates.

Defining a profile is a very important issue, as long as the programs' design must lead to obtain a certain profile of engineer.

Differences were noted between the present profile, what the work market demands and a prospective of a wanted profile.

Considering the market's demands, three kinds of business companies were described, each with different requirements on the engineers they hire.

a) Multinational or large size companies: they hire not very specialized professionals, who are then "customized" according to the style end specific needs of the company.

b) Medium size companies: they need specialized engineers, who are hired to complete special tasks, usually for short periods of time.

c) Small size companies: they prefer wide range engineers, with an accent on the methodological approach more than on specialized information. Often they are satisfied with an advanced undergraduate.

Thinking about the characteristics of the engineer's profile, as asked for by business companies, the list shown in TABLE I was composed.

Table I. Characteristics of the engineer's profile, as asked for by business companies.

- an agent of change and transformation
- a translator of technological products bought abroad
- a young graduate with:
  - ✓ good academic performance
  - ✓ ability to solve problems, fast and well
  - ✓ ability to analyze, make abstractions and interpret the outcomes
  - ✓ capability to understand the overall business and rotate trough different positions
  - ✓ capability to learn continuously
  - ✓ a good knowledge of the latest technological advances to perform specialized tasks
  - ✓ ability to be a chief

On the other hand, some features were mentioned that are not required in the market: research engineers, "superspecialized" engineers, goods production area engineers.

Knowledge required

The participants agreed that most important is the knowledge of basic sciences (mathematics, physics, chemistry) and, in a smaller proportion, basic technologies.

In addition to this, proficiency in materials science and computer use are required. There are also some human sciences topics that an engineer must be acquainted with: human resources, legal issues, economics and finance, team work and leadership, management skills, foreign languages.

Skills and attitudes of the wanted profile

Again, we show in TABLE II the skills and attitudes that the participants pointed out as required or wanted when considering an engineer.

TABLE II. Skills and attitudes that the participants pointed out as required or wanted when considering an engineer.

• high potential level	• creativity	• basic intellectual skills: abstraction, conceptualization
• decision making ability	• commitment	• good development of scientific thinking skills
• flexibility	• team working skills	• capability to face changing and complex situations
• leadership	• dynamic attitude	• ability to respond effectively when facing new problems

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• communication skills	• managing skills	• capability to learn in the work environment • good practical approach to problems

As a result of the discussion on this subject, some general recommendations were stated, that we write below:

- To define a profile of the graduate in Engineering, attention should be paid to the present requirements of industry and society, but also a keen look to the future should be made.
- When reviewing the curriculum to update the specific contents the University should also take as an explicit goal to improve the human and management skills of the graduates.
- Undergraduates should learn the basic and general concepts and skills at the University, together with a suitable orientation in one of the main branches of Engineering (which these branches are, remains as an issue to be discussed, reviewed and redefined). The task of further specializing should be accomplished at work or at the University's postgraduate level.

A model of education based on the solution of complex problems with open answers was suggested. It is supposed that it would help to develop the mentioned skills while preparing the graduates to adapt to different positions or types of work.

Implications Of The Study

It is remarkable that, in spite of the very heterogeneous characteristics of the participants, many coincidences were found. Also, the different points of view that they exposed allowed the discussion of many issues, and the proposal of many ideas. Even when some of these ideas were not supported by a majority of the participants, their appearance enhances the level of the debate.

The commitment and creativity that the participants showed in this activity allows us to propose that this material can be taken as a real basis for curricular reform in Engineering university studies.